PROCEEDINGS

OF

THE ROYAL SOCIETY.

1836. No. 28.

December 8, 1836.

FRANCIS BAILY, Esq., V.P. and Treas., in the Chair.

Charles Mackenzie, Esq., who at the last Anniversary had ceased to be a Fellow from the non-payment of his annual contribution, was, at this meeting, re-admitted by ballot into the Society, agreeably to the provision of the Statutes.

A paper was read, entitled, "Inquiries respecting the Constitution of Salts. Of Oxalates, Nitrates, Phosphates, Sulphates, and Chlorides." By Thomas Graham, Esq., F.R.S. Edin., Professor of Chemistry in the Andersonian University of Glasgow, Corresponding Member of the Royal Academy of Sciences of Berlin, &c. Communicated by Richard Phillips, Esq., F.R.S.

The results which the author had obtained from his former experiments, and of which he communicated an account to the Royal Society, suggested to him the probability that the law with respect to water being a constituent of sulphates, would extend also to any hydrated acid and the magnesian salt of that acid. As he had already found that the sulphate of water is constituted like the sulphate of magnesia, so he now finds the oxalate of water to resemble the oxalate of magnesia, and the nitrate of water to resemble the nitrate of magnesia. His researches render it probable that the correspondence between water and the magnesian class of oxides extends beyond their character as bases; and that in certain subsalts of the magnesian class of oxides, the metallic oxide replaces the water of crystallization of the neutral salt, and discharges a function which was thought peculiar to water. In the formation of a double sulphate, the author finds that a certain degree of substitution or displacement occurs; such as the displacement of an atom of water pertaining to the sulphate of magnesia, by an atom of sulphate of potash, to form the double sulphate of magnesia and potash. The same kind of displacement appears to occur, likewise, in the construction of double oxalates; and the application of this principle enables us to understand the constitution both of the double and super-oxalates, and to explain the mode of their derivation.

The author then proceeds to apply these principles to the analysis of the oxalates; and 1st, of the oxalate of water, or hydrated oxalic acid; 2ndly, of oxalate of zinc; 3rdly, of oxalate of magnesia; 4thly, of oxalate of lime; 5thly, of oxalate of barytes; 6thly, of oxalate of potash; 7thly, of binoxalate of potash; 8thly, of quadroxalate of potash; 9thly, of oxalate of ammonia; 10thly, of oxalate of soda; 11thly, of binoxalate of soda; and lastly, of the double oxalates, such as, 1st, oxalate of potash and copper; 2ndly, oxalate of chromium and potash; 3rdly, oxalate of peroxide of iron and potash; and 4thly, of oxalate of peroxide of iron and soda.

In the second section he treats of the nitrates; and 1st, of hydrated nitric acid, or the nitrate of water; 2ndly, of nitrate of copper; 3rdly, of subnitrate of copper; 4thly, of nitrate and subnitrate of bismuth; 5thly, of nitrate of zinc; 6thly, of nitrate of magnesia; and 7thly, of supposed double nitrates and supernitrates. He concludes, from his experiments on this subject, that there is no proof of the existence of a single supernitrate.

In the third section he discusses the constitution of the phosphates. Phosphoric acid, he observes, is quite peculiar in being capable of combining with bases in three different proportions; forming, besides the usual class of monobasic salts, containing one atom of acid to one atom of protoxide as base, two other anormal classes of salts, in which two or three atoms of base are united to one atom of acid, namely, the pyrophosphates and the common phosphates, as they are usually denominated, but which the author proposes to designate by the terms, *bibasic*, and *tribasic* phosphates. Arsenic acid forms only one class of salts; but that class is anormal; every member of it containing three atoms of base to one atom of acid, like the common, or tribasic, phosphates. These anormal classes of phosphates and arseniates, with, perhaps, the phosphites, are, the author believes, the only known salts to which the ordinary idea of a subsalt is truly applicable: all other reputed subsalts being probably neutral in composition, as has been shown by the author in the case of the subnitrate of copper; for they all bear an analogy to this salt in their small solubility and other properties, while they exhibit little resemblance to those classes of phosphates and arseniates which really possess more than one atom of base. A table is then given, containing the formulæ expressing the composition of the most important phosphates, together with a new nomenclature by which, in accordance with his views, the author proposes to designate these salts. He then enters into the details of experiments illustrating the composition of, 1st, tribasic phosphate of soda, ammonia, and water, (or the microcosmic salt of the old chemists): 2ndly, tribasic phosphate of zinc and water, (or what is commonly called phosphate of zinc): 3rdly, tribasic arseniate of magnesia and water, (the common arseniate of magnesia): 4thly, tribasic phosphate of magnesia and water, (or ordinary phosphate of magnesia): and 5thly, tribasic phosphate of magnesia and ammonia, (or ammoniaco-magnesian phosphate).

In the fourth section he treats of sulphates, and supports, by fur-

ther evidence, the opinion he formerly advanced; that as bisulphate of potash is a double sulphate of water and potash, and therefore neutral in its composition, so, with the sole exception of the anormal class already noticed, all salts, usually considered as bisalts are, in like manner, really neutral in composition. He shows that this theory is strictly applicable to the red chromate of potash, which appeared to present a difficulty.

The chlorides are next considered. The law followed by the chlorides of the magnesian class of metals appears to be that they have two atoms of water strongly attached to them, and which may, therefore, be regarded as constitutional. Thus, chloride of copper crystallizes with two atoms of water, and with no lower proportion; but several chlorides of this class have two or four atoms more; the proportion of water advancing by multiples of two atoms. The chlorides have probably their analogues in the cyanides, although we are less acquainted with the single cyanides of iron, copper, &c.; but the disposition of the protocyanide of iron, and of the cyanide of copper to combine with two atoms of cyanide of potassium, may depend on the cyanides of iron and of copper possessing, like the corresponding chlorides, two atoms of constitutional water, which are displaced by two atoms of the alkaline cyanide in the formation of the double cyanides.

December 15, 1836.

WILLIAM LAWRENCE, Esq., V.P., in the Chair.

Thomas Graham, Esq., M.A., was elected a Fellow of the Society.

A paper was read, entitled, "Further Observations on the Optical Phenomena of Crystals." By Henry Fox Talbot, Esq., F.R.S.

The author had described, in a former paper, the remarkable circular mode of crystallization frequently occurring from a solution of borax in phosphoric acid, and producing, when examined by the polarising microscope, the appearance of a black cross, with four sectors of light, and occasionally coloured rings, upon each crystal. In the present memoir, he describes some deviations from the usual forms of crystalline circles; the most striking varieties consisting in the cross being itself highly coloured, instead of black, upon a white ground. The author shows that these crystals consist of boracic acid alone, resulting from the decomposition of the borax by the phosphoric acid. He gives an explanation of the optical appearances they present on the hypothesis of their being constituted by an aggregate of acicular crystals, radiating from a central point; and the whole circle being of variable thickness at different distances from its centre, and acting with great energy on polarised light. Other modes of crystalline formation, dependent chiefly on the pre-

sence or absence of combined water, are next described. These sometimes produce crystals composed of two opposite sectors of a circle, united at the centre; at other times, they exhibit irregular elongated shapes, having a stem, either subdivided at both extremities into minute diverging fibres, or abruptly truncated; and occasionally they present regular geometric forms: but, whatever be their shape, they undergo, in general, spontaneous changes in the course of one or two days after they have been formed.

The author then notices a property belonging to some crystals, similar to that possessed by the tourmaline, of analysing polarized light; for which reason he denominates them *analytic crystals*. As an example, he mentions those obtained by dissolving sulphate of chromium and potash in tartaric acid by the aid of heat. A drop of this solution, placed on a plate of glass, soon yields, by evaporation, filmy crystals, which frequently have this property. The plumose crystals of boracic acid, when crystallized from a solution of borax in phosphoric acid, also possess this analytic power, and present very beautiful appearances when viewed with the polarizing microscope. Another instance occurs in the oxalate of potash and chromium, a salt whose optical properties have been investigated by Sir David Brewster. If gum arabic be added to a solution of this salt, and a drop of it be put between two plates of glass, a very beautiful arborescent, but microscopic crystallization takes place, composing a multitude of minute prisms, growing, as if by a species of vegetation, and variously arranged in sprigs and branchlets, often resembling in miniature, the tufts of marine confervæ. A similar plumose appearance, accompanied with the same analytic properties, is obtained from the evaporation of a drop of a mixed solution of nitre and gum arabic. This analytic effect is shown to be the consequence of the high degree of doubly refractive power possessed by these crystalline filaments, and which exists even in those whose diameter is evanescent on microscopic examination. The author entertains hopes that it will be possible to obtain large and permanent artificial crystals, which may possess the advantages of the tourmaline, without the inconvenience resulting from its dark colour.

December 22, 1836.

FRANCIS BAILY, Esq., V.P. and Treasurer, in the Chair.

William Page Wood, Esq., was elected a Fellow of the Society.

"First Memoir on the Theory of Analytical Operations." By the Rev. Robert Murphy, M.A., F.R.S., Fellow of Caius College, Cambridge.

The author considers the elements of which every distinct analytical process is composed, as of three kinds; the first, being the *sub-*

ject, that is, the symbol on which a certain notified operation is to be performed; the second, the *operation* itself, represented by its own symbol; and the third, the *result*, which may be connected with the former two by the algebraic symbol of equality. The operations are either *monomial* or *polynomial*; *simple* or *compound*; and with respect to their order, are either *fixed* or *free*. He uses the term *linear* operations to denote those of which the action on any subject is made up by the several actions on the parts, connected by the signs *plus* or *minus*, of which the subject is composed; and these linear operations likewise may be monomial or polynomial.

A variety of theorems for the developement of functions of a very general nature are then deduced from expansions of the fundamental expressions, derived from the principles stated in the beginning of this memoir: and various laws embracing the relations subsisting between analytical operations, and the fundamental formulæ for their transformation are investigated.

"Observations and Experiments on the Solar Rays that occasion Heat; with the application of a remarkable property of these rays to the construction of the Solar and Oxy-hydrogen Gas Microscopes." By the Rev. J. B. Reade. Communicated by J. G. Children, Esq., Sec. R.S.

The method employed by the author for obtaining, by a combination of lenses, the convergence to foci of the colorific solar rays, together with the dispersion of the calorific rays, consists in making a beam of solar light, which contains both kinds of rays, pass, after it has been converged to a focus by a convex condensing lens, through a second convex lens, placed at a certain distance beyond that focus: that distance being so adjusted as that the calorific rays, which, from their smaller refrangibility, are collected into a focus more remote from the first lens than the colorific rays, and consequently nearer to the second lens, shall, on emerging from the latter, be either parallel or divergent; while the colorific rays, which, being more refrangible, had been collected into a focus nearer to the first lens, and more distant from the second, will be rendered convergent by this second lens; so that the second focus, into which they are thus collected, will exhibit a brilliant light without manifesting any sensible degree of heat. The light so obtained may be advantageously applied to the solar, and to the oxy-hydrogen microscopes, from its producing no injurious effects on objects inclosed in Canada balsam, or even on living animalcules exposed to its influence.

Another improvement in the construction of the microscope employed by the author, consists in the cell for holding objects being made to move quite independently of the field glass; so that the best focus is obtained by an adjustment which does not disturb the field of view.

The Society then adjourned over the Christmas vacation, to meet again on the 12th of January next.

January 12, 1837.

CAPTAIN SMYTH, R.N., Vice-President, in the Chair.

"An attempt to account for the discrepancy between the actual Velocity of Sound in Air or Vapour, and that resulting from theory." By the Rev. William Ritchie, LL.D., F.R.S. Professor of Natural Philosophy at the Royal Institution, and in University College, London.

Sir Isaac Newton determined from theory that the velocity of the undulations of an elastic medium generally is equal to that which a heavy body acquires in falling by the action of gravity through half the height of a homogeneous atmosphere of that medium; but the actual velocity of sound in atmospheric air is found to be one eighth greater than what is assigned by that formula. This difference was attempted to be accounted for by Newton on the supposition that the molecules of air are solid spheres, and that sound is transmitted through them *instanter*. Laplace endeavoured to reconcile the difference between theory and observation, by the hypothesis that heat is disengaged from each successive portion of air during the progress of the condensed wave. The author of the present paper regards the hypothesis of Laplace as a gratuitous and improbable assumption; the falsehood of which he thinks is apparent from the fact that a rarefied wave advances through air with the same velocity as a condensed wave, which would not be the case if in either instance their progress were influenced by the heat evolved. He then enters into calculations to show that if the molecules of water be assumed as incompressible, and, when at the temperature of maximum density, very nearly in absolute contact, we ought, in estimating the velocity of sound in steam, to add to the velocity given by the formula of Newton, the rectilinear space occupied by the molecules; which, if a cubic inch of water be converted into a cubic foot of steam, will be one twelfth of the distance. By comparative experiments with a tuning-fork held over a tube, closed at one end, and containing at one time air, and at another steam, and also by similar trials with organ pipes of variable lengths, the author found a close agreement between his theory and observation. He also shows that this theory furnishes the means of determining, *à priori*, the density of a liquid, if the velocity of sound in the vapour of that liquid be given. In a postscript he adduces further confirmation of the truth of his theory by observations on the velocity of sound in hydrogen gas, and in carbonic acid gas.

January 19, 1837.

FRANCIS BAILY, Esq., V.P. and Treasurer, in the Chair.

Benjamin Bond Cabbell, Esq., Charles Holland, M.D., John Urpath Rastrick, Esq., and Samuel Solly, Esq., were elected Fellows.

"Researches towards establishing a Theory of the Dispersion of Light." By the Rev. Baden Powell, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford.

The author here prosecutes the inquiry on the dispersion of light which was the subject of his former papers published in the Philosophical Transactions for 1835 and 1836, extending it to media of higher dispersive powers, which afford a severer test of the accuracy of M. Cauchy's theory. He explains his methods of calculation and the formulæ on which his computations are founded, and which are different from those employed in his former investigations: and then states the results in a tabular form. On the whole he concludes that the formula, as already deduced from the undulatory theory, applies sufficiently well to the case of media whose dispersion is as high as that of oil of anise-seed: or below it, such as nitric, muriatic, and sulphuric acids, and the essential oils of angelica, cinnamon, and sassafras, balsam of Peru, and kreosote. It also represents, with a certain general approximation to the truth, the indices of some more highly dispersive bodies. The author therefore considers it as extremely probable that the essential principle of the theory has some real foundation in nature. From the regularity which he finds in the deviation of observation from theory, he thinks it likely that the formula only requires to receive some further developement, or extension, in order to make it apply accurately to the higher cases, while it shall still include the simpler form which so well accords with the lower.

"A few remarks on the Helm Wind." By the Rev. William Walton, of Allenheads, near Hexham. Communicated by P. M. Roget, M.D., Sec. R.S.

On the western declivity of a range of mountains, extending from Brampton, in Cumberland, to Brough, in Westmoreland, a distance of 40 miles, a remarkably violent wind occasionally prevails, blowing with tremendous violence down the western slope of the mountain, extending two or three miles over the plain at the base, often overturning horses with carriages, and producing much damage, especially during the period when ripe corn is standing. It is accompanied by a loud noise, like the roaring of distant thunder: and is carefully avoided by travellers in that district, as being fraught with considerable danger. It is termed the *helm wind*; and its presence is indicated by a belt of clouds, denominated the *helm bar*, which rests in front of the mountain, three or four miles west of its summit, and apparently at an equal elevation, remaining immoveable during twenty-four or even thirty-six hours, and collecting or attracting to itself all the light clouds which approach it. As long as this bar continues unbroken, the wind blows with unceasing fury, not in gusts, like other storms, but with continued pressure. This wind extends only as far as the spot where the bar is vertical, or immediately over head; while at the distance of a mile farther west, as well as to the east of the summit of the mountain, it is not unfrequently almost a perfect calm. The author details the particulars

of an expedition which he made with a view to investigate the circumstances of this remarkable meteorological phenomenon, and proposes a theory for its explanation.

"A Meteorological Journal kept at Allenheads, 1400 feet above the level of the Sea, from the 1st of May to the 1st of November, 1836." By the Rev. William Walton. Communicated by P. M. Roget, M.D., Sec. R.S.

January 26, 1837.

FRANCIS BAILY, Esq., V.P. and Treasurer, in the Chair.

A paper was read, "On the Structure of the Brain in Marsupial Animals." By Richard Owen, Esq., F.R.S., Hunterian Professor of Anatomy to the Royal College of Surgeons.

The author describes a remarkable modification in the commissural apparatus, apparently provided with a view to establish communications between the cerebral hemispheres, which he has observed in the brains of marsupial animals, and which has hitherto been regarded as constituting the essential difference between the brains of oviparous and mammiferous vertebrata, but which he considers as indicating a certain relation between the greater perfection of that organ, resulting from the superior magnitude of the great commissure, or corpus callosum, and the placental mode of developement in the true mammalia. In a former paper he adduced evidence tending to show that both a small developement of the cerebral organ, and an inferiority of intelligence are the circumstances in the habits and structure of this singular tribe of animals most constantly associated with the peculiarities of their generative economy: and the repeated dissections he has since made, an account of which is given in the present paper, have afforded him the most satisfactory confirmation of this coincidence, between a brief intra-uterine existence, together with the absence of a placental connexion between the mother and the fœtus, and an inferior degree of cerebral developement. Thus, on comparing the structure of the brain in the Beaver and in the Wombat, he finds that the corpus callosum, or great commissure which unites the supraventri- cular masses of the hemispheres in the former, as well as in all other placentally developed mammalia, and which exists in addition to the fornix, or hippocampal commissure, is wholly absent in the latter animal: and that a similar deficiency exists in the brain of the Great and Bush Kangaroos, of the Vulpine Phalanger, of the Ursine and Mange's Dasyurus, and of the Virginian Opossum; whence he infers that it is probably the characteristic feature of the structure of the marsupial division of mammalia. In this modification of the commissural apparatus, the Marsupiata present a structure of brain which is intermediate between that of the Placental Mammalia and Birds; and hence the Marsupiata, together with the Monotremata, may be regarded as constituting a distinct and peculiar group in the former of these classes, although they include forms, which typify the different orders of the ordinary Mammalia.

February 2, 1837.

FRANCIS BAILY, Esq., V.P. and Treasurer, in the Chair.

"Observations on the Electro-chemical Influence of long-continued Electric Currents of Low Tension." By G. Golding Bird, Esq., F.L.S., F.G.S., Lecturer on Experimental Philosophy at Guy's Hospital. Communicated by Thomas Bell, Esq., F.R.S.

The author, after observing that the brilliant discoveries in electrochemistry obtained by Sir Humphry Davy were effected by the employment of voltaic currents of high intensity, elicited by means of large batteries, adverts to the labours of M. Becquerel, to whom we are indebted for the knowledge of the chemical agency of feeble currents in reducing several refractory oxides to the metallic state: and also to those of Dr. E. Davy, Bucholtz, and Professor Faraday in effecting decompositions of other substances by similar means. In prosecuting this branch of inquiry, the author employed an apparatus analogous to that of Professor Daniell, for obtaining an equal and continuous current of low intensity from a single pair of plates: the metallic solution, in which a copper-plate was immersed, being contained in a glass tube, closed at the bottom by a diaphragm of plaster of Paris, and itself plunged in a weak solution of brine contained in a larger vessel, in which a plate of zinc was immersed; and a communication being established between the two metallic plates by connecting wires. By the feeble, but continuous current thus elicited, sulphate of copper is found to be slowly decomposed, affording beautiful crystals of metallic copper. Iron, tin, zinc, bismuth, antimony, lead, and silver may, in like manner, be reduced, by a similar and slightly modified process; in general appearing with metallic lustre, and in a crystalline form, and presenting a remarkable contrast in their appearance to the irregular, soft, and spongy masses obtained from the same solutions by means of large batteries. The crystals of copper rival in hardness and malleability the finest specimens of native copper, which they much resemble in appearance. The crystallization of bismuth, lead, and silver, by this process, is very beautiful; that of bismuth being lamellar, of a lustre approaching to that of iron, but with the reddish tint peculiar to the former metal. Silver may thus be procured of the whiteness of snow, and usually in the form of needles. Some metals, such as nickel, which, when acted on by currents from large batteries, are deposited from their solutions as oxides only, are obtained, by means of the apparatus used by the author, in a brilliant metallic form. He farther found that he could in this way reduce even the more refractory metallic oxides, such as silica, which resist the action of powerful batteries, and which M. Becquerel could only obtain in alloy with iron. By a slight modification of the apparatus he was enabled to form amalgams both of potassium and of sodium with mercury, by the decomposition of solutions of chlorides of those bases; and in like manner ammonium was easily reduced, when in contact with mercury, by the influence of a feeble voltaic current. In this last

experiment it was found that an interruption to the continuance of the current, even for a few seconds, is sufficient to destroy the whole of the product which had been the result of the previous long-continued action; the spongy ammoniacal amalgam being instantly decomposed, and the ammonia formed being dissolved in the surrounding fluid.

February 9, 1837.

FRANCIS BAILY, Esq., V. P. and Treasurer, in the Chair.

Edmund Halswell, Esq., who, at the last Anniversary, had ceased to be a Fellow, from the non-payment of his annual contribution, was, at this meeting, readmitted by ballot into the Society, agreeably to the provision of the statutes.

A paper was read, in part, entitled, "On the Elementary Structure of Muscular Fibre of Animal and Organic Life." By Frederick Skey, Esq., Assistant Surgeon to St. Bartholomew's Hospital. Communicated by John Bostock, M.D., F.R.S.

February 16, 1837.

The Right Honourable the EARL OF BURLINGTON, V.P., in the Chair.

The reading of a paper entitled, "On the Elementary Structure of Muscular Fibre of Animal and Organic Life." By Frederick Skey, Esq., Assistant Surgeon to St. Bartholomew's Hospital. Communicated by John Bostock, M.D., F.R.S., was resumed and concluded.

The author concludes, from his microscopic examinations of the structure of muscular fibres, that those subservient to the functions of animal life have, in man, an average diameter of one 400dth of an inch, and are surrounded by transverse circular striæ varying in thickness, and in the number contained in a given space. He describes these striæ as constituted by actual elevations on the surface of the fibre, with intermediate depressions, considerably narrower than the diameter of a globule of the blood. Each of these muscular fibres, of which the diameter is one 400dth of an inch, is divisible into bands or fibrillæ, each of which is again subdivisible into about one hundred tubular filaments, arranged parallel to one another, in a longitudinal direction, around the axis of the tubular fibre which they compose, and which contains in its centre a soluble gluten. The partial separation of the fibrillæ gives rise to the appearance of broken or interrupted circular striæ, which are occasionally seen. The diameter of each filament is one 16,000dth of an inch, or about a third part of that of a globule of the blood. On the other hand, the muscles of organic life are composed, not of fibres similar to those above described, but of filaments only; these filaments being interwoven with each other in irregularly disposed lines of various thickness; having for the most part a longitudinal direction, but forming a kind of untraceable network. They are readily distinguishable from tendinous fibres, by the

filaments of the latter being uniform in their size, and pursuing individually one unvarying course, in lines parallel to each other. The fibres of the heart appear to possess a somewhat compound character of texture. The muscles of the pharynx exhibit the character of animal life; while those of the œsophagus, the stomach, the intestines, and the arterial system, possess that of inorganic life. The determination of the exact nature of the muscular fibres of the iris presented considerable difficulties, which the author has not yet been able satisfactorily to overcome.

A paper was also in part read, entitled, "On the Function of the Medulla Oblongata and Medulla Spinalis, and on the Excito-motory System of Nerves." By Marshall Hall, M.D., F.R.S. L. and E., &c.

February 23, 1837.

The Right Honourable the EARL OF BURLINGTON, V.P., in the Chair.

Richard Partridge, Esq., was elected a Fellow of the Society.

The reading of Dr. Marshall Hall's paper was resumed, but not concluded.

March 2, 1837.

WILLIAM LAWRENCE, Esq., V.P., in the Chair.

The reading of a paper, entitled, "On the Function of the Medulla Oblongata and Medulla Spinalis, and on the Excito-motory System of Nerves." By Marshall Hall, M.D., F.R.S., L. and E., &c., was resumed and concluded.

The author begins by observing that a former memoir of his, entitled, "On the Reflex Function of the Medulla Oblongata and Medulla Spinalis," published in the Philosophical Transactions for 1833, has been translated into German, and favourably spoken of by Professor Muller, of Berlin. He states that his object in the present paper is to unfold what he calls a great principle in physiology; namely, that of the special function, and the physiological and pathological action and reactions of the true spinal marrow, and of the excito-motory nerves. The two experiments which he regards as affording the type of those physiological phenomena and pathological conditions, which are the direct effects of causes acting in the spinal marrow, or in the course of the motor nerves, are the following:—1. If a muscular nerve be stimulated, either mechanically by the forceps, or by means of galvanism passed transversely across its fibres, the muscle or muscles to which it is distributed are excited to contract.—2. The same result is obtained when the spinal marrow itself is subjected to the agency of a mechanical or galvanic stimulus. The following experiment, on the other hand, presents the type of all the actions of the reflex func-

tion of the spinal marrow, and of the excito-motory system of nerves, and of an exclusive series of physiological and pathological phenomena :—If in a turtle, from which the head and sternum have been removed, we lay bare the sixth or seventh intercostal nerve, and stimulate it either by means of the forceps or galvanism, both the anterior and posterior fins, with the tail, are immediately moved with energy. Hence the author infers the existence: 1st, of a true spinal marrow, physiologically distinct from the chord of intra-spinal nerves; 2ndly, of a system of excito-motory nerves, physiologically distinct from the sentient and voluntary nerves; and, 3rdly, of currents of nervous influence, incident, upwards, downwards, and reflex with regard to the spinal marrow.

A review is then taken of the labours of preceding physiologists relative to the functions of the nervous system: in which the author criticises the reasonings of Whytt, Legallois, Mr. Mayo, Dr. Alison, and Professor Muller; and illustrates his own peculiar views by several experiments and pathological observations, which appear to him to show that muscular movements may occur, under circumstances implying the cessation of sensation, volition, and every other function of the brain; and that these phenomena are explicable only on the hypothesis that impressions made on a certain set of nerves, which he terms *excito-motory*, are conveyed to a particular portion of the spinal marrow belonging to that system, and are thence reflected, by means of certain motor nerves, upon certain sets of muscles, inducing certain actions. The same actions may also be the result of impressions made directly either on the spinal marrow or on the motor nerves. He accordingly considers that the whole nervous system may be divided into,—1st, the *cerebral*, or the sentient and voluntary; 2ndly, the *true spinal*, or the excitor and motor; and, 3rdly, the *ganglionic*, or the nutrient, the secretory, &c. The excito-motory system presides over ingestion and exclusion, retention and egestion, and over the orifices and sphincters of the animal frame: it is therefore the nervous system of respiration, deglutition, &c., and the source of tone in the whole muscular system. The true spinal system is the seat or nervous agent of the appetites and passions, but is also susceptible of modification by volition. This theory he proceeds to apply to the explanation of several phenomena relating to the motions of the eyelids, pharynx, cardia, larynx, muscles of inspiration, sphincter ani, expulsors of the fæces and semen, to the tone of the muscular system generally, and to actions resulting from the passions. Lastly, he considers its application to various diseased states of the same functions, as manifested in cynic spasm, vomiting, asthma, tenesmus, strangury, crowing inspiration, convulsions, epilepsy, tetanus, hydrophobia, and paralysis.

Reference is made, in the course of the paper, to several drawings and diagrams, which, however, have not yet been supplied.

March 9, 1837.

The Rev. ADAM SEDGWICK, M.A., V.P., in the Chair.

A paper was read, entitled, " Researches on the Tides. Seventh Series. On the Diurnal Inequality of the Height of the Tide, especially at Plymouth and at Sincapore : and on the Mean Level of the Sea." By the Rev. W. Whewell, A.M., F.R.S., Fellow of Trinity College, Cambridge.

The diurnal inequality which the author investigates in the present paper, is that by which the height of the morning tide differs from that of the evening of the same day ; a difference which is often very considerable, and of great importance in practical navigation, naval officers having frequently found that the preservation or destruction of a ship depended on a correct knowledge of the amount of this variation. In the first section of the paper he treats of the diurnal inequality in the height of the tides at Plymouth, at which port good tide observations are regularly made at the Dock Yard ; and these observations clearly indicate the existence of this inequality. As all the other inequalities of the tides have been found to follow the laws of the equilibrium theory, the author has endeavoured to trace the laws of the diurnal inequality by assuming a similar kind of correspondence with the same theory; and the results have confirmed, in the most striking manner, the correctness of that assumption. By taking the moon's declination four days anterior to the day of observation, the results of computation accorded, with great accuracy, with the observed heights of the tides : that is, the period employed was the fifth lunar transit preceding each tide.

In the second section, the observations made on the tides at Sincapore from August 1834 to August 1835, are discussed. A diurnal inequality was found to exist at that place, nearly agreeing in law and in amount with that at Plymouth ; the only difference being that, instead of four days, it was found necessary to take the lunar declination a day and a half preceding the tide ; or, more exactly, at the interpolated, or north lunar transit, which intervened between the second and third south transit preceding the tide. The diurnal inequality at Sincapore is of enormous magnitude, amounting in many cases to six feet of difference between the morning and evening tides ; the whole rise of the mean tide being only seven feet at spring tides, and the difference between mean spring and neap tides not exceeding two feet.

In the third section, the author considers the diurnal inequalities at some other places, and the general law of its progress. The change which the *epoch*, (that is, the anterior period at which the moon's declination corresponds to the amount and direction of the inequality,) in particular, undergoes, is a subject of great interest. At Liverpool, the epoch is found to be about six days and a quarter ; at Bristol, it is nearly six days ; and at Leith, it is as much as twelve days. On the east coast of America, it appears to be *zero*. On the coasts of

Spain, Portugal, and France, it is successively two, and three days; and on those of Cornwall and Devonshire, four days; thus observing a tolerably regular augmentation as it is traced along the line of coast from the shores of the Atlantic to the Firth of Forth, but travelling more slowly than the other inequalities.

In section fourth, the author treats of certain extreme cases of diurnal inequality; particularly those which produce the phenomenon of a single tide in the twenty-four hours: such as that noticed by Capt. Fitzroy at King George's Sound, on the south coast of New Holland; and that of Tonquin, referred by Newton to the interference of two tides arriving by different channels, but probably owing to the operation of the same law as that which gives rise to the diurnal inequality.

In section fifth, the author considers the subject of the mean height of the sea; that is, the height midway between low water and high water each day: and arrives at the result that it is very nearly constant.

March 16, 1837.

The Right Honourable the EARL OF BURLINGTON, V.P., in the Chair.

John Burnet, Esq., was elected a Fellow of the Society; and Charles Julius Roberts, M.D., was balloted for, but not elected.

A paper was read, entitled, "On the Tides." By John William Lubbock, Esq., F.R.S., &c. &c.

Since the author presented his last paper on the tides to the Society, his attention has been directed to ascertain the three following points: namely, 1st, Whether, from the discussion of the Liverpool observations with reference to a previous transit, these observations present the same kind of agreement with Bernouilli's theory as those of London: 2ndly, Whether, by taking into account a greater number of observations, the results given in his last paper remain sensibly unaltered: and 3rdly, Whether the *establishment* of the Port of London varies sensibly in different years; and whether the removal of the old London bridge has occasioned any difference. In order to elucidate these points, he procured the assistance of Mr. Jones and Mr. Russell to compute numerous tables; employing for that purpose a further sum of money placed at his disposal with this view by the British Association for the Advancement of Science. The results contained in the tables here presented, are all laid down in diagrams, on the same plan as those contained in his last paper, by which means they are much more readily understood. The author finds that the semi-menstrual correction for the interval at Liverpool presents the same agreement with observation as had been before noticed; while the form or law of the semi-menstrual correction for the height is also the same as that indicated by the observations; but in order to render the agreement complete it would be necessary to change the epoch, or to make a slight movement of the theory-curve in the diagrams. This

remarkable difference also obtains in the London semi-menstrual correction for the height.

The calendar month inequality at Liverpool, considered as resulting implicitly from the corrections due to changes in the declinations of the luminaries, and in the sun's parallax, agrees generally with Bernouilli's theory, and with the results deduced from the London observations given in the author's last paper.

The author finds that the *Establishment* of the Port of London has been subject to changes even since the beginning of the present century, and he notices the difficulty of predicting the time of high water with accuracy unless these changes can be accounted for. He also cites a very ancient Tide Table, from which it would appear that formerly the time of high water at London was an hour later than it is at present.

The Society then adjourned over the Easter recess, to meet again on the 6th of April next.